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ABSTRACT

This 5-week unit on constructing wood agricultural buildings is designed for the junior or senior year of the regular agribusiness course of study or as part of the agricultural mechanics program. In outline form, the unit is divided into eight major performance objectives. Each objective is subdivided into the areas of content, suggested teaching-learning activities, resources, and evaluation. The major objectives (consisting of separate sections) relate to the subjects of (1) importance of wood products to modern agriculture, (2) materials, (3) calculating a bill of materials, (4) laying out a frame building, (5) framing a building, (6) cutting a common rafter, (7) roofing a building, and (8) constructing exterior walls. (Author)

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Constructing Wood Agricultural Buildings

An Instructional Unit for High School
Teachers of Vocational Agriculture

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1974

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UNIT: CONSTRUCTING WOOD AGRICULTURAL BUILDINGS

Major Objective:

Upon completion of this unit, the student will have developed the skills necessary for constructing farm buildings of wood products.

Performance Objectives: The student will

I. Describe the importance of wood products to modern agriculture.

II. Identify the materials commonly used in wood construction.

III. Calculate a bill of materials.

IV. Lay out a building foundation.

V. Frame a building.

VI. Cut a common rafter.

VII. Roof a building.

VIII. Construct exterior walls.

UNIT: CONSTRUCTING WOOD AGRICULTURAL BUILDINGS

Suggested Teaching Time

This unit on constructing wood agricultural buildings should take approximately five weeks to teach and should be taught primarily in the mechanics laboratory.

Place of the Unit in the Course of Study

The unit may be taught during the junior or senior year of the regular agribusiness course of study or it could also be used as a part of the full-time agricultural mechanics program taught during the junior and/or senior years. Regardless of where it is taught, the unit should aid the student in developing skills necessary for constructing wood agricultural structures.

Suggestions for Introducing the Unit

In introducing the unit, the uses and qualities of wood should be stressed. Wood is an important building material that can be used for many structures on the farm.

Interest can be created by taking a field trip to a farm in the community that has made good use of wood structures. Other methods of creating interest could be showing slides or films that point out the many advantages of wood on the farm.

After interest has been created, involve the students in discussing the different steps to follow in constructing quality wood structures. Differences of opinion may arise as to the steps to follow, thereby creating more interest.

I. The student will describe the importance of wood products to modern agriculture.

A. Content

1. Uses of wood and wood products in modern agriculture

a. Farm buildings

(1) Conventional or pole type barns

(2) Sheds

(a) Machinery shed
(b) Storage shed
(c) Livestock, loafing, feeding or breeding sheds

(3) Utility buildings such as pump house or farm shop

b. Farm dwellings

c. Fences and gates

d. Livestock feeding and handling equipment

e. Special purpose buildings

(1) Brooder house

(2) Farrowing house

(3) Feed processing and storage house

2. Advantages of using wood and wood products in construction

a. Relatively inexpensive material when compared to many building materials

b. Lightweight

c. Easy workability

d. Available locally in the sizes and grades desired in most instances

B. Suggested Teaching-Learning Activities

1. Involve the students in making a list of the wood buildings on their farm. Conduct a discussion concerning the use of wood in the different types of farm buildings.

2. Involve students in determining the cost of lumber. Compare lumber prices to the prices of other building materials used in agricultural construction.

3. Divide the class into teams, with a specified captain for each team, to develop a list of agricultural uses for wood products. Develop a composite list of uses on the chalkboard.

4. Visit a local agricultural farm and let the students make a list of all the uses of wood products they can observe.

5. Show the film, "Lumber For Homes," Audio Visual Services, University of Kentucky, Lexington, Kentucky.

C. Resources

1. Books

Practical Farm Buildings, pp. 21-23.

Farm Builder's Handbook, pp. 31-33.

2. Films

"Lumber For Homes," 22 minutes.

D. Evaluation

Have the students discuss, either orally or in writing, the uses and advantages of wood for agricultural construction. Evaluate the students based on the number of uses and qualities listed in the discussion.

II. The student will identify the materials commonly used in wood construction.

A. Content

1. Lumber

a. Types

(1) Softwood
(2) Hardwood
(3) Plywood

b. Grades of hardwood or softwood lumber

(1) Yard

(a) Lumber commonly used for construction
(b) Basic grades of yard lumber

-- Select or number 1
-- Construction or number 2
-- Standard or number 3
-- Utility or number 4
-- Economy or number 5

Note: Standard and utility grades of yard lumber are most commonly used in agricultural construction.

(2) Furniture or hardwood
(3) Structural

c. Grades of plywood

(1) Grades according to quality

(a) A-grade, which is free from knots
(b) B-grade, which contains patched knots
(c) C-grade, which contains small knots
(d) D-grade, which contains wood splits and knot holes up to 2 inches

(2) Grades according to use

(a) Exterior
(b) Interior

2. Fasteners

   a. Nails

      (1) Common
      (2) Box
      (3) Spike
      (4) Casing

   b. Bolts

      (1) Carriage
      (2) Stove
      (3) Machine

   c. Lag screws

3. Basic set of carpenter tools

   a. Combination square
   b. Framing square
   c. Hammer
   d. Jack and block plane
   e. Screwdrivers of various sizes
   f. Chisels of various sizes
   g. Hand drill
   h. Crosscut, rip, finish, and keyhole saw

      Note: Electrical power tools such as electric drills and electric saws are used in wood construction.

B. Suggested Teaching-Learning Activities

1. Visit a local building supply dealer. Involve the students in identifying the different types and grades of lumber and the different wood fasteners.

2. Set up a display of the different types and grades of lumber and of wood fasteners. Identify and discuss the different construction items.

3. Show transparency HS 53 H-1, "Grades of Yard Lumber," page A-22, while discussing the different grades of yard lumber.

4. Discuss the different types of fasteners while showing transparency HS 53 H-2, "Types of Fasteners," page A-23.

C. Resources

1. Books

Farm Builder's Handbook, Chapter 3.

Practical Farm Buildings, Chapter 14.

2. Bulletins and Circulars

"Selecting Lumber and Other Building Material"

3. Transparencies

HS 53 H-1-2, pp. A-22-23.

D. Evaluation

Have the students identify the different carpentry tools, grades of lumber, and wood fasteners. Evaluate the students based on the number of correct identifications.

III. The student will calculate a bill of materials.

A. Content

1. Terms associated with calculating a bill of materials

a. Bill of material--an itemized list of all the materials needed including number of pieces and dimensions of each for a construction project

b. Surfaced lumber--dressed lumber resulting from running through a planer

c. Board foot--a piece of lumber
1" x 12" x 12"

d. Running foot--the foot length of lumber regardless of the thickness or the width

2. Major components of a bill of materials

a. Lumber

(1) Number of pieces
(2) Type and grade
(3) Board feet
(4) Finish
(5) Cost per piece

b. Fasteners

c. Roofing material

3. Figuring board feet

a. Lumber is usually priced on the basis of 1,000 board feet or a similar dimension

b. Formula = $\frac{\text{Number of pieces x Thickness x Width x Length}}{12}$

4. Steps in calculating a bill of materials

a. Determine number of board feet of various sizes of lumber needed.

b. Determine amount and type of fasteners needed.

c. Determine amount and type of roofing material needed.

d. Calculate cost for lumber, fasteners, and roofing material.

e. Total all costs.

Note: Each student at this point should be developing plans for constructing a wood building. This construction could be completed on a team basis. Objective III through VIII should relate directly to constructing these buildings.

B. Suggested Teaching-Learning Activities

1. Develop a list of terms associated with calculating a bill of materials. Involve the students in defining those terms through individual research.

2. Examine sample blueprints to determine the materials needed to build the structure shown in the blueprint. Involve the students in calculating a bill of materials from the blueprint.

3. Involve each student in completing at least three problems using the formula for calculating board feet.

4. Involve the students in figuring a bill of materials for a structure being built on the home farm.

C. Resources

1. Books

Farm Builder's Handbook, Appendix B.

The Farm Shop, pp. 22, 30-31.

Practical Farm Buildings, p. 28.

D. Evaluation

Have each student figure a bill of materials for a particular structure. Evaluate the student based on the accurateness of his calculations.

IV. The student will lay out a building foundation.

A. Content

1. Factors to consider in laying out a building

a. Location

b. Permanence

c. Use

2. Materials and equipment needed

a. Stakes

b. String or cord

c. Line level

d. Plumb bob

e. Carpenter's level

f. Boards for batters

g. Tacks

3. Methods of laying out foundation lines

a. Right-triangle method using 6' x 8' x 10' measurements

(1) Establish base line by marking out one end or side of foundation.

(2) Set stakes A and B at the corners.

(3) Drive a small nail in the top of stake A and B to accurately locate the two corners.

(4) Place stake F on line A - B and 6' from stake A.

(5) Drive nail in stake F exactly 6' from nail in stake A.

(6) Place stake E so that its center will be exactly 8' from stake A and 10' from stake F. (The corner represented by the angle E-A-F is a right angle.)

(7) Extend line A-E to D and the third corner will be established.

(8) Corner C can be found by making desired measurements from D and B.

(9) Set up batter boards.

(10) Stretch strings over the corner stakes.

(11) Use powdered lime to mark foundation lines.

(12) Remove batter boards and strings.

Note: For smaller buildings you may use 3' x 4' x 5' right triangle. For larger buildings use a 30' x 40' x 50' or 60' x 80' x 100' right triangle.

b. Equal diagonal measurements

(1) Measure sides to determine if they are equal.

(2) Measure ends to determine if they are equal.

(3) Measure diagonally from corner A to corner C and B to D.

(a) If measurements are equal, corners are square.

(b) If measurements are not equal, move corners (making sure to keep correct dimensions) until measurements are equal.

B. Suggested Teaching-Learning Activities

1. Involve students in a discussion of the importance of keeping the corners of building foundations square and accurate. Point out to the students that a strong, neat, easily constructed building must begin with accurate building lines.

2. Show students transparency HS 53 H-3, "Right Triangle Method," page A-24, while discussing how to apply the right triangle method.

3. Show transparency HS 53 H-4, "Diagonal Measurement Method," page A-25, while discussing the application of this method.

4. Divide the class into groups of three or four and have them lay out foundation lines on the shop floor using chalk to mark the lines.

5. Take the class outside on the school grounds and have the small groups lay out foundation lines.

6. Involve the class in laying out a foundation for a building structure on the school grounds or on the farm of one student or local person in the community.

C. Resources

1. Books

Farm Mechanics Text and Handbook, pp. 571, 579.

2. Bulletins and Circulars

"Foundation for Farm Buildings," pp. 22-23.

3. Transparencies

HS 53 H-3-4, pp. A-24-25.

D. Evaluation

Have the students lay out foundation lines for specified dimensions. Evaluate the students on the accuracy of the lines and the right angles of the corners.

V. The student will frame a building.

A. Content

Note: This objective will discuss the procedures to follow in constructing a stud wall frame. The procedures outlined can also be applied when constructing a pole frame.

1. Types of wall framing

a. Stud

b. Pole

c. Masonry

2. Materials needed

a. Carpentry tools

b. Studs 2" x 4"

c. Top plate similar dimensions to studs

d. Wood fasteners consisting primarily of nails

e. Bracing boards 1" x 4"

f. Headers for door and window openings

3. Steps to follow in framing a building

a. Set bottom wood foundation to correct dimensions of building making sure foundation corners are square.

b. Space and nail stud walls to bottom foundation or sole plate.

Note: If floor is to be laid in building, floor joists must be placed 16" on center across width of building and subfloor nailed in place at a 45 degree angle to the joists before stud walls are nailed.

(1) Use 2" x 4" studs.
(2) Space studs 24" on center.
(3) Nail studs to bottom plate or foundation using three 10d nails or four 8d common nails.

c. Place and nail top plate.

(1) Use top plate of 2" x 4" material.
(2) Use single top plate where rafters are placed equal distances apart as studs.
(3) End nail single top plate to studs with two 16d common nails.
(4) Lap plates at corners and intersecting partitions.
(5) Nail other studs to top plate using 8d common nails.

d. Brace stud walls.

(1) Nail 1" x 4" or wider board to inner or outer face of stud wall, sole plate, and top plate at or near each corner.
(2) Set brace at 45 degree angle.
(3) Nail brace to studs and plates using 8d common nails.

e. Frame openings for doors and windows to correct dimensions.

Note: Step e, is optional depending on the type of building being constructed.

(1) Use double studs if openings exceed stud spacing in width.
(2) Use two 2" x 8" boards for header if truss occurs over an opening up to 8'.
(3) Nail double studs with 16d common nails.
(4) Make inner stud continuous from header to sole plate.
(5) End nail each header member with two 16d common nails.

B. Suggested Teaching-Learning Activities

1. Visit a local construction site to allow the students to observe the framing procedure.

2. Divide the students into teams. Involve each team in framing a building.

C. Resources

1. Books

Farm Builder's Handbook, Chapter 5.

Farm Utility Building, Chapter C.

Practical Farm Buildings, Chapter 5.

D. Evaluation

Have each student or team of students frame a building. Evaluate them based on the correctness of the procedures followed and the strength of the finished product.

VI. The student will cut a common rafter.

A. Content

1. Basic terminology to rafter cutting

a. Span--horizontal distance from outside edges of the top plate

b. Ridge board--2" x 4" board onto which the plumb cuts of the rafters are nailed

c. Run--measurement from a plumb line from the top plate to the center of the ridge board

d. Rise--vertical distance from the top plate to the center of the ridge board

2. Equipment needed

a. 2" x 4" boards for rafters

b. Framing square

c. Steel tape

d. Folding rule

e. Chalkline

f. Electric skill-saw or 8-point crosscut handsaw

g. Sawhorses

3. Steps to follow in cutting common rafters*

a. Determine the inches or rise per foot of run for the rafter.

b. Determine the length of the rafter.

c. Mark off the length of the rafter in steps.

d. Mark out the plumb cut.

e. Mark out the seat cut.

f. Allow for 1/2 the thickness of the ridge board.

*Adapted from Practical Farm Buildings by James S. Boyd.

g. Mark out the rafter tail.

h. Cut the rafter.

i. Check the fit of the seat and plumb cut.

B. Suggested Teaching-Learning Activities

1. Invite into the classroom or shop a local carpenter. Ask him to demonstrate how to properly cut rafters.

2. Display two rafters, one properly cut and one improperly cut. Discuss the causes of poorly cut rafters.

3. Divide the students into teams and involve each team in properly cutting rafters.

4. Discuss the basic terminology of rafter cutting while showing transparency HS 53 H-5, "Rafter Terminology," page A-26.

5. Show transparency HS 53 H-6, "Rafter Cuts," page A-27, while discussing the different cuts that must be made on a common rafter.

C. Resources

1. Books

Practical Farm Buildings, Chapter 5.

Farm Builder's Handbook, pp. 73, 208-209.

2. Bulletins and Circulars

"Rafter Layout with the Framing Square."

D. Evaluation

Involve each student or teams of students in cutting common rafters. Evaluate the student based on the accurateness of the rafter cut.

VII. The student will roof a building.

A. Content

1. Types of roofing material

a. Wood shingles

b. Composition asphalt

(1) Roll roofing
(2) Asphalt or strip shingles
(3) Built-up asphalt roofs

c. Steel or sheet iron

d. Aluminum

2. Materials needed

a. Decking or sheathing material

b. Nails

c. Carpentry tools

d. Appropriate roofing material

3. Steps in installing roofing material

a. Wood shingles

(1) Nail decking to rafters.

(a) Nail 1" x 4" decking boards with 8d common nails flush with ends of rafter.

(b) Space additional decking boards 5" on center and continue decking to ridge board.

(2) Place wood shingles.

(a) Lay a double first run at the eaves to cover expansion space between shingles.

(b) Nail shingles with galvanized shingle nails 3/4" from edge and 6" from butts allowing for the covering of the nails by succeeding rows.

(c) Allow ½" space between shingles.

(d) Lap all shingles at least 1½".

(e) Space shingles properly to assure that the grooves are properly aligned.

b. Roll asphalt roofing

(1) Sheath the roof with #1 common 525 sheathing.

(2) Measure horizontally the roof line; then add ½" to each end to determine the length of roll asphalt needed.

(3) Place one layer of asphalt over the length of the roof.

(4) Spread asphalt mastic on all top edges of the asphalt roofing.

(5) Nail through mastic with 1 3/4" galvanized nails except for top span.

(6) Lay second course of asphalt.

(7) Apply mastic to second course.

(8) Nail through mastic on the bottom of the second course and top of the first course by inserting nails 18" apart.

(9) Continue nailing second course until ridge board is reached.

(10) Extend 10" strip of roofing over ridge board, spread mastic, and nail.

c. Asphalt shingles

(1) Sheath the roof with plywood or center-matched roof sheathing no wider than 6".

(2) Install galvanized roof edging around all outside edges of the roof.

(3) Cover roof area with number 15 asphalt felt and nail as needed to prevent wind damage.

(4) Place first row of shingles at the eaves with the butts up.

(5) Begin finish course with 2/3 of a shingle to allow joint lines to be parallel with the building.

(6) Nail each shingle with six large-headed galvanized 1¼' roofing nails per shingle.

(7) Nail 1" back and 1½" on each side of the notch being sure to be 6" above the butt of the shingle.

(8) Repeat courses breaking joints until ridge is reached.

d. Built-up roof

(1) Sheath or deck the roof with plywood or center-matched roof sheathing no wider than 6".

(2) Nail roof edging in place.

(3) Measure and cut a length of roofing the length of the roof deck.

(4) Nail roofing in place with 1¼" galvanized roofing nails driven through 1" diameter tin washers.

(5) Apply 20" of hot asphalt per 100 square feet of roof.

(6) Repeat steps (3), (4), and (5) above until three layers are deposited.

(7) Spread thin layer of gravel on roof before last layer of asphalt hardens.

e. Metal roofing (steel or sheet iron)

(1) Nail girths or rafter ties 12" on center to hold metal.

(2) Begin installation at end farthest away from the strong winds.

(3) Nail 5-V galvanized metal on girths with 2" lead-headed nails making sure head just touches the metal.

(4) Space nails 3" apart on ridges.

Note: 1-1¼ pounds of nails are required per square of roofing.

f. Aluminum

(1) Nail girths or rafter ties 12" on center to hold aluminum.

(2) Begin installation at end farthest away from strong winds.

(3) Nail aluminum to girths with seven sharpened nails including neoprine washers.

Note: 100 nails are required per square of roofing.

B. Suggested Teaching-Learning Activities

1. Discuss with the students the different types of roofing materials and the values of each.

2. Set up a display of the different types of roofing materials. Involve the students in identifying each type.

3. Invite into the classroom a local building supplier. Ask him to discuss the different types of roofing materials.

4. Visit agricultural construction sites within the community. Observe the type of roofing being used and the steps in applying that roofing.

5. Divide the class into teams and involve each team in roofing a building.

C. Resources

1. Books

Practical Farm Buildings, pp. 99-104.

Farm Builder's Handbook, Chapter 6.

D. Evaluation

Have each student or groups of students roof a building. Evaluate the student based on the procedure followed and the finished product.

VIII. The student will <u>construct exterior walls</u>.

A. <u>Content</u>

1. Types of exterior wall material

a. Dressed sheeting

b. Plywood

(1) Exterior
(2) Interior

c. Hardboard

(1) Masonite
(2) Partial board
(3) Celatix

2. Materials needed

a. Exterior wall material

b. Nails or other fasteners

c. Carpentry tools

(1) Hammer
(2) Square
(3) Electric saw
(4) Carpenter's pencil

3. Steps to follow:

Note: The procedure outlined will apply to constructing exterior walls primarily of dressed sheeting and plywood. A decorative covering can be applied over these walls if desired.

a. Strike level line nail straight edge across horizontal length of building to serve as beginning and ending point.

b. Nail sheeting to bottom plate plumb with horizontal straight edge.

c. Nail with 8d common nails 4" apart across the width of the boards, locating the nails 1" from the ends of the board and at all center bracings.

B. Suggested Teaching-Learning Activities

1. Visit agricultural construction sites within the community to observe the construction of exterior walls.

2. Divide the class into teams and involve each team in constructing an exterior wall.

C. Resources

1. Books

Farm Builder's Handbook, pp. 53-54.

Practical Farm Buildings, pp. 51-52.

D. Evaluation

Involve each student or groups of students in constructing an exterior wall. Evaluate the student based on the procedures followed and the product produced.

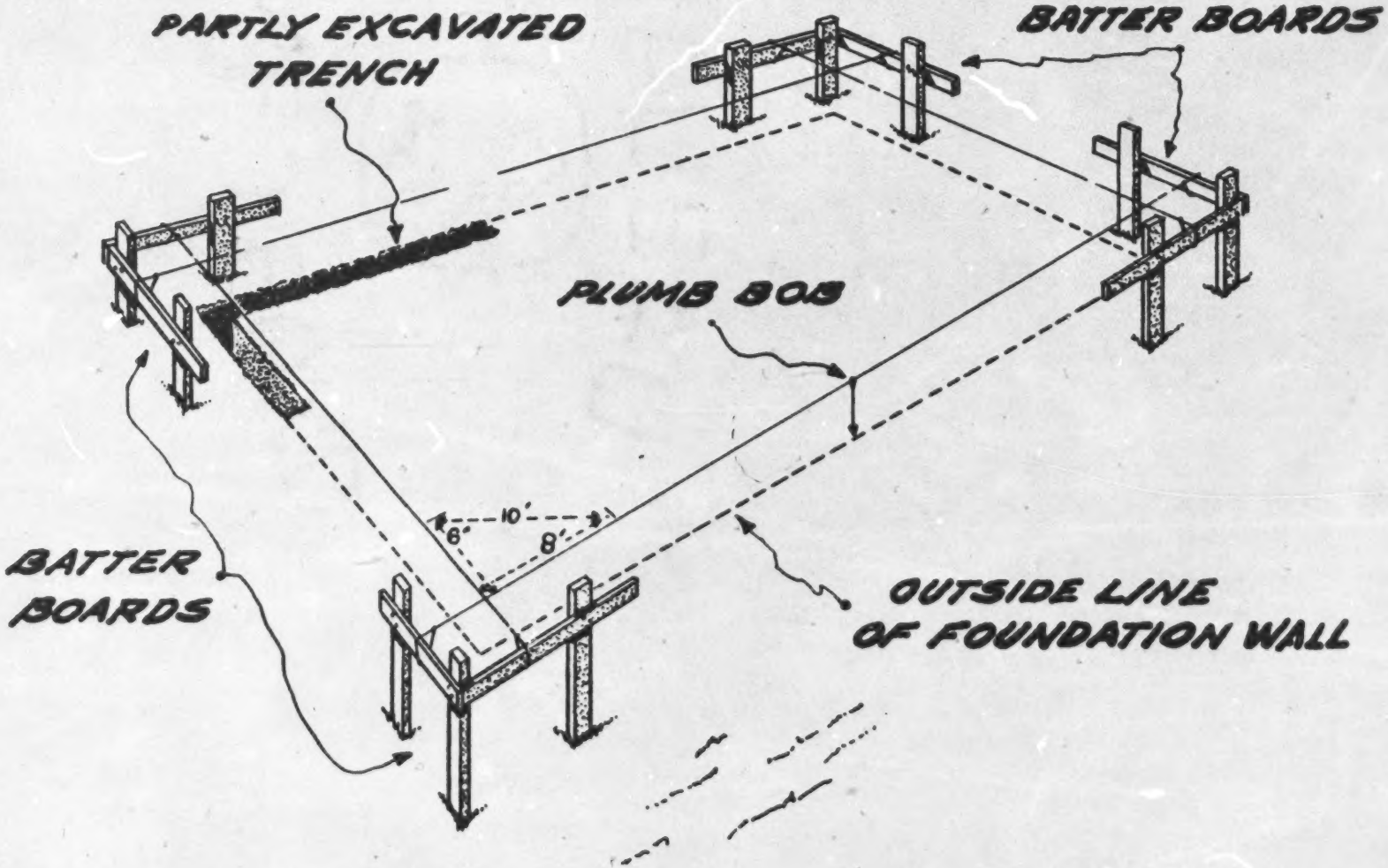
APPENDIX

GRADES OF YARD LUMBER

1. Number 1 -- Select
2. Number 2 -- Construction
3. Number 3 -- Standard
4. Number 4 -- Utility
5. Number 5 -- Economy

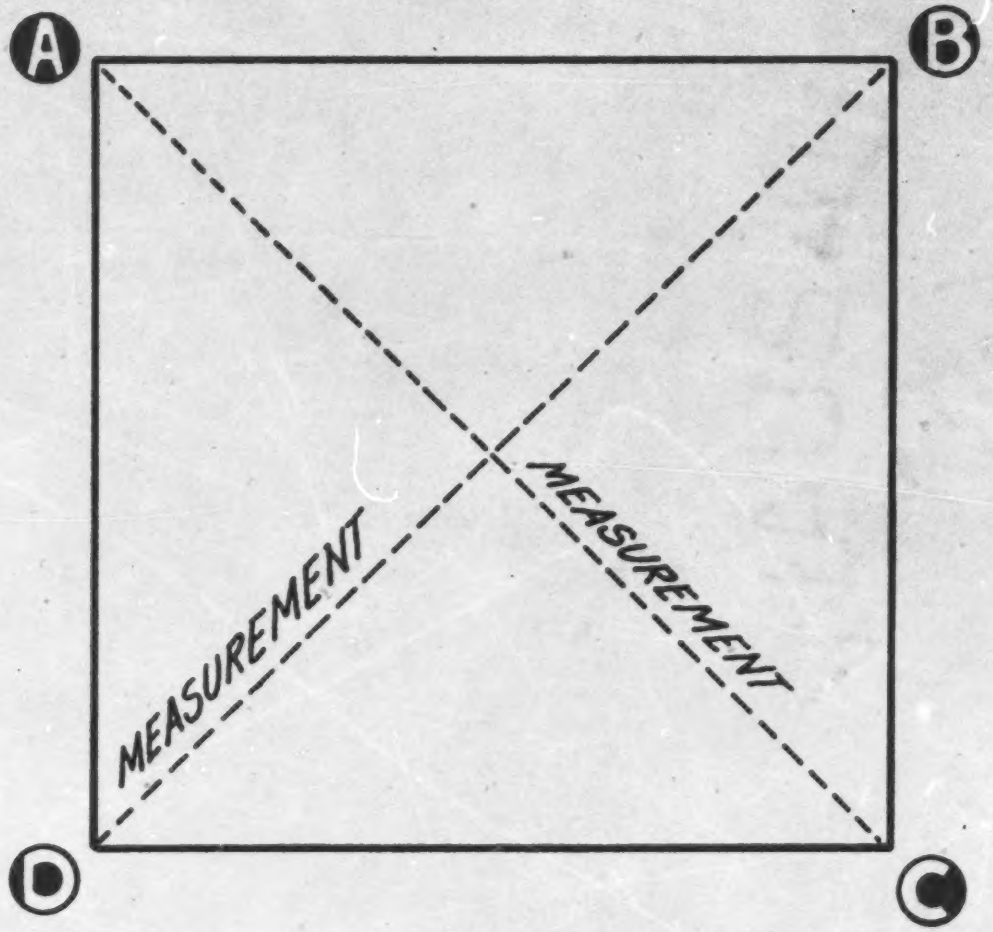
FAIRMONT CHEM. CORP. NEW CASTLE, PA. 16105 U.S.A. A-24

RIGHT
TRIANGLE METHOD OF LAYING OUT FOUNDATION



HS 53 H-3

EQUAL DIAGONAL MEASUREMENTS FOR LAYING OUT FOUNDATION LINES



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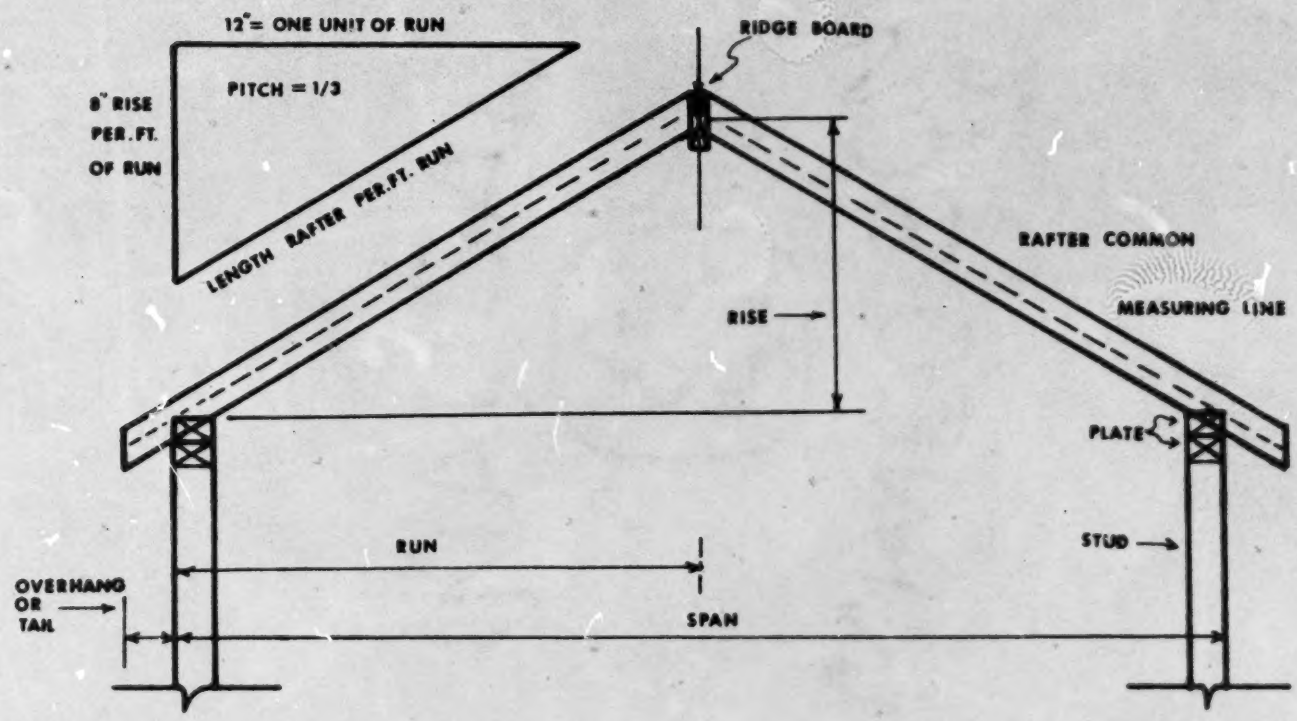
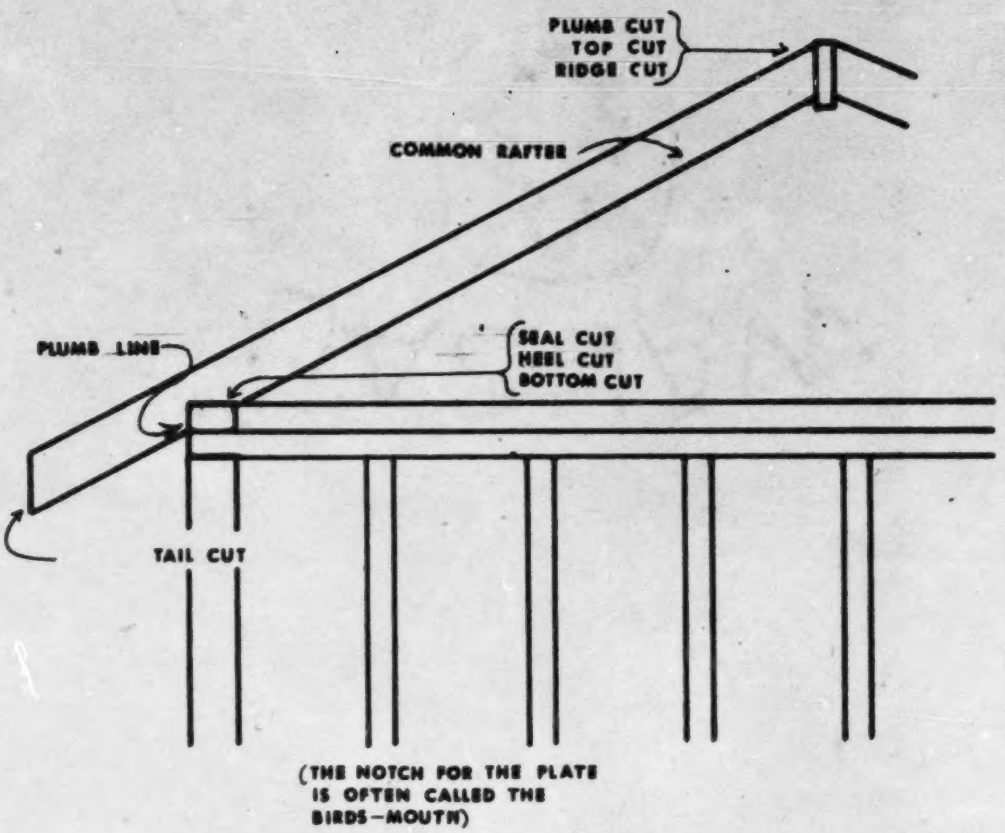
A-25

HS 53 H-4

BUILDING ROOF NOMENCLATURE



RAFTER CUTS



STRATEG. CMBR. DEVE. CNTR. UK. 1959-61

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* Denotes references cited in the Unit.

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* Denotes references cited in the Unit.

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